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Avian and Pandemic Influenza Knowledge and Risk Perception in Southern Minnesota

by

Holly J. Munch

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in Community Health Education

Minnesota State University, Mankato

Department of Health Science

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Avian and Pandemic Influenza Knowledge and Risk Perception in Southern Minnesota

Holly J. Munch

This thesis has been examined and approved by the following members of the student's committee.

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Abstract

Avian influenza is an important public health issue because such viruses have the potential to mutate into a pandemic influenza virus with widespread, even global, morbidity and mortality. Studies have indicated that knowledge about avian and pandemic influenza and perception of pandemic risk are low among the public and even in the health professions. This study was undertaken to evaluate the level of avian and pandemic influenza knowledge and risk perception among adults in southern Minnesota with a view to preparing effective educational interventions and improving preparedness for an influenza pandemic. An 18-question electronic survey was administered to 99 people in the study population to measure overall influenza knowledge, overall risk perception, and whether these variables differed by employment role, educational level, or experience with severe seasonal influenza. Overall knowledge score was 10.03 on a 13-point scale. Overall risk perception was 8.86 on a 15-point scale. Influenza knowledge did not differ among the study sample by employment, education, or influenza experience. Risk perception did not differ by educational level or influenza experience, but did differ by employment role. The author concluded that, in the study sample, knowledge was weak in the areas of prevention and understanding the pandemic potential of avian influenza and that educational interventions would improve influenza knowledge and pandemic preparedness. Future studies should focus on a larger and more representative sample to validate knowledge gaps.

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Table of Contents

Abstract.....	iii
Acknowledgements.....	iv
List of Tables and Figures.....	viii
Chapter 1: Avian and Pandemic Influenza as a Public Health Issue.....	1
Introduction.....	1
Statement of the Problem.....	2
Significance of the Problem.....	3
Hypotheses and Research Questions.....	4
Limitations.....	6
Delimitations.....	7
Assumptions.....	8
Definition of Terms.....	8
Chapter 2: Review of Related Literature.....	10
Introduction.....	10
Structure and Behavior of HPAI Viruses.....	10
Structure of HPAI viruses.....	10
Behavior of HPAI viruses.....	11
Human Infections.....	11
History of human infections.....	11
Risk factors.....	12
Human infections to date.....	13

Human exposures during 2015 bird outbreak.....	13
Prevention.....	14
Pandemic Preparedness.....	15
Health sector preparedness.....	15
Government and business sector preparedness.....	16
General public preparedness: Knowledge and perception.....	17
General public preparedness: Psychological preparedness.....	18
Pandemic Potential of Viruses	19
Poultry Farm Biosecurity.....	20
Surveillance and Epidemiology.....	21
Alternative Viewpoints on Pandemic Risk and Preparedness.....	23
Risk Assessment.....	24
Theoretical Basis.....	24
Chapter 3: Research Methodology.....	28
Introduction.....	28
Description of and Rationale for Research Design.....	28
Subject Selection.....	29
Instrumentation.....	29
Procedures.....	30
Data Collection.....	30
Data Processing and Analysis.....	31
Chapter 4: Results.....	33

Introduction.....	33
Sampling and Employer Participation.....	33
Demographic Information.....	33
Research Question 1.....	34
Research Question 2.....	35
Research Questions 3 and 4.....	37
Research Questions 5 and 6.....	39
Research Questions 7 and 8.....	39
Summary.....	39
Chapter 5: Discussion, Conclusions, and Recommendations.....	40
Introduction.....	40
Summary of Study.....	40
Interpretation of Results.....	41
Conclusions.....	43
Recommendations for Research and Practice.....	43
References.....	45
Appendix.....	57

List of Tables

Table 1. Research Questions and Analysis Methods.....	32
Table 2. Frequency of correct responses to knowledge questions.....	36
Table 3. Results of perception of preparedness question for all respondents.....	37

List of Figures

Figure 1. Perceptions of likelihood of an influenza pandemic occurring in respondent's community by employment sector.....	38
Figure 2. Perceptions of severity of personal impact of an influenza pandemic occurring in respondent's community by employment sector.....	38

Chapter 1: Avian and Pandemic Influenza as a Public Health Issue

Introduction

Highly pathogenic avian influenza (HPAI) is a rapidly transmissible viral disease of birds, particularly waterfowl such as ducks and geese. While HPAI does not usually cause illness in wild birds, it results in severe illness and mortality in domestic chickens and turkeys (Centers for Disease Control and Prevention [CDC], 2015a). HPAI only rarely affects humans, but unpredictable genetic changes in the virus causing efficient bird-to-human or human-to-human transmission could result in a pandemic influenza (flu) strain (CDC, 2015b; Mänz et al., 2016; Mehle, Dugan, Taubenberger, & Doudna, 2012). Such a pandemic could potentially kill millions of people worldwide, as did the 1918 pandemic flu (CDC, 2016a). Therefore, avian influenza presents a significant potential public health problem.

HPAI was first discovered in 1996 in a flock of geese in China and has since been detected in birds in over 50 countries, mostly in Asia, Africa, the Middle East, and Europe (CDC, 2015b). Because infection of a domestic flock with HPAI rapidly sickens the entire flock and can result in 90% to 100% mortality, current practice is to depopulate or “cull” the entire flock upon detection of the virus, which can cause major economic losses for poultry farmers (CDC, 2015a).

Contact between wild infected birds and poultry is both a causal factor and a moderating factor for HPAI (Bahl et al., 2016). Poultry can also be infected from viruses carried by humans from other infected flocks (United States Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS) Veterinary Services, 2016), making farm biosecurity a critical component of prevention. While most poultry farms have biosecurity

protocols in place, the recent Midwestern epidemic of 2015 indicates that current measures are inadequate (USDA-APHIS Veterinary Services, 2015).

It is difficult to anticipate how influenza viruses will evolve and which strains are likely to evolve into a potential pandemic flu. Likelihood of such mutations is moderated by high-density poultry production, contact between poultry and wild birds, and inadequate biosecurity allowing transmission of virus between farms (Pepin et al., 2013; USDA-APHIS Veterinary Services, 2015). Human cases of HPAI carry a mortality rate of up to 60% (US Department of Health & Human Services [USDHHS], 2016). As of July 2016, 854 human cases of avian influenza had been reported worldwide, with 450 deaths (53% mortality) (World Health Organization [WHO], 2016).

While the HPAI strain responsible for most human cases is H5N1, in early 2017 mutations to the H7N9 strain caused this formerly low-pathogenic virus to become highly pathogenic in poultry in China and the southeastern United States. H7N9 also became able to cause illness and death in humans (WHO, 2017a). As of March 16, 2017, the WHO reported 1307 human cases of H7N9, of which at least 489 were fatal (37% mortality) (WHO, 2017b).

Statement of the Problem

While few studies of pandemic flu knowledge have been conducted in the US (Vaughan & Tinker, 2009), studies in Canada (Maunula, 2007) and Australia (Marshall, Ryan, Robertson, Street, & Watson, 2009) have found that overall awareness and understanding of avian and pandemic flu are low among the public. In these studies, large percentages of the study

populations did not know what HPAI and pandemic influenza are. They were also unaware of the potential of HPAI to develop into a pandemic flu strain. Finally, these studies and others (Balicer, Omer, Barnett, & Everly, 2006; Barnett et al., 2009; Oberdorfer, 2008; Prati, Pietrantoni, & Zani, 2011; Schneider, 2007) indicated that many laypersons and health professionals lack the knowledge or skills to be prepared for a flu pandemic.

Such evidence indicates that pandemic flu knowledge may be low in southern Minnesota as well. Because of this region's high poultry population (Ye, 2015), it may be particularly susceptible to the emergence of a pandemic flu strain from an avian flu strain. Therefore, it is very important that residents of the region have an adequate level of knowledge about avian and pandemic flu so they can be prepared in the event of a pandemic.

A survey was used to gather data on avian and pandemic influenza knowledge and risk perception across various professions and population groups in southern Minnesota. These data may be used to suggest improvements to communications that will increase HPAI awareness and risk avoidance behaviors. This study's target population was adults over age 18 in southern Minnesota. Background and technical information on viruses was derived from the literature only and was not directly investigated. Published data on poultry infection control measures and economic consequences of outbreaks was also utilized. Primary data was collected using a survey designed to measure influenza knowledge and perceptions of preparedness for a pandemic.

Significance of the Problem

As mentioned above, currently HPAI is a disease primarily affecting domestic poultry. A series of related outbreaks of HPAI in the US from December 2014 to June 2015 led to the slaughter of 7.5 million turkeys and 42.1 million chickens. Federal reimbursements to poultry farmers for their losses cost US taxpayers some \$950 million (USDA-APHIS Veterinary Services, 2016). Minnesota is the top producer of turkeys and ranks #12 in overall poultry production in the US (Ye, 2015). The state's 3746 poultry farms comprise a \$1.2 billion industry, which was severely affected by the 2015 avian flu outbreak.

However, HPAI is not just a bird disease. It can affect human health through rare direct transmission (Yuen et al., 1998), but the potential of viral mutation to a pandemic flu strain is the greater concern. HPAI is a public health issue that affects the entire population and whose study involves epidemiology and health education and promotion. The APHIS HPAI preparedness report (USDA-APHIS Veterinary Services, 2016) reveals the need for better communication with the public following the 2015 Midwestern HPAI outbreak. This study provides data on current community pandemic flu awareness, and its results may be used to indicate the adequacy of current influenza risk communication and preparedness.

A primary reason for conducting the study is that in the event of an influenza pandemic, there will be insufficient time and resources to prepare communication and response plans. In the event of a pandemic, community preparedness is of the utmost importance to minimize mortality and morbidity. Therefore, plans and materials need to be prepared to address the current threat of HPAI and expand knowledge and risk perception in preparation for a possible

pandemic. Understanding the current state of a community's flu risk perception and level of preparedness is essential to improving health outcomes in the case of such a pandemic.

Hypotheses and Research Questions

Four hypotheses were proposed for this study:

- 1) Knowledge and risk perception of avian/pandemic flu are low in the general population of southern Minnesota.
- 2) Individuals' knowledge and risk perception of avian/pandemic flu differs by employment sector.
- 3) Individuals' knowledge and risk perception of avian/pandemic flu differs by educational level.
- 4) Individuals' knowledge and risk perception of avian/pandemic flu differs by personal experience with severe seasonal flu.

To test these hypotheses, the following research questions (RQs) were posed:

RQ1) What is the overall level of knowledge about avian and pandemic influenza in the study population?

RQ2) What is the overall level of risk perception regarding avian and pandemic influenza in the study population?

RQ3) To what extent is knowledge of avian and pandemic influenza different among individuals in various employment roles?

RQ4) To what extent is risk perception of avian and pandemic influenza different among individuals in various employment roles?

RQ5) What is the relationship between educational level and individuals' avian and pandemic influenza knowledge?

RQ6) What is the relationship between educational level and individuals' avian and pandemic influenza risk perception?

RQ7) To what extent does experience with severe seasonal influenza correlate with an individual's avian and pandemic influenza knowledge?

RQ8) To what extent does experience with severe seasonal influenza correlate with an individual's avian and pandemic influenza risk perception?

Limitations

Limitations of this study involve its data resources, research subjects, time and budget constraints, and research methods.

- 1) The study sample was obtained by convenience and limited to those institutions and businesses granting the author permission to survey employees.
- 2) Respondents have varying educational backgrounds related to the topic (lay to professional), and therefore were expected to have various levels of knowledge of avian and pandemic influenza.
- 3) Because participants were recruited through employers, the study sample reflects only the employed component of the population and are not representative of the population as a whole.

- 4) The study period was limited to late February through March 2017 (approximately five weeks) and results do not reflect the ultimate stages of influenza knowledge in individuals or the study population.
- 5) There was no budget for this study because data was collected online using the Qualtrics program (Qualtrics, LLC, 2017).
- 6) The use of surveys means that the quality of the data is dependent on honest responses to the questions.

Delimitations

- 1) The study was limited geographically to southern Minnesota and the results are not generalizable to other regions.
- 2) The study period was limited to late February and March 2017; therefore the data are a “snapshot” of subjects’ knowledge and perceptions at the time of the survey.
- 3) Chosen study variables were employment sector, educational level, and experience with severe seasonal influenza. There may be other factors influencing influenza knowledge that were not explored in this study, such as an outbreak of HPAI in local poultry farms, media coverage of HPAI, or the severity of current seasonal influenza.
- 4) Inquiries into the literature and other published information were limited to databases searchable from Minnesota State University, Mankato library and government publications.

- 5) The primary research method used is the cross-sectional correlational method supplemented with the descriptive method. Therefore, any trends observed can only be treated as correlations and not causation.
- 6) Some extraneous variables that may affect the study results and were not controlled are 1) race, 2) gender, 3) cultural or philosophical beliefs about food animals (such as veganism), and 4) political viewpoint.

Assumptions

Following are the assumptions of this study:

- 1) Respondents will have sufficient English proficiency to accurately answer survey questions.
- 2) Respondents will answer survey questions based on current knowledge and will not “look up” answers to survey questions.
- 3) Responses will be representative of the group surveyed.
- 4) Individuals’ knowledge and perception of flu influences their flu risk behaviors.

Definition of terms

Biosecurity: Infection prevention and control measures taken by poultry producers to reduce risk of HPAI (USDA-Animal and Plant Health Inspection Service (APHIS) Veterinary Services, 2015)

Depopulation: Culling (killing) the animals in an infected flock (APHIS Veterinary Services, 2016)

Highly pathogenic avian influenza (HPAI): Type A avian influenza virus usually in the form of H5Nx where x is a variable antigen, usually asymptomatic in wild birds but causes severe illness and rapid mortality in domestic chickens and turkeys; has the potential to evolve into human pandemic influenza (CDC, 2015b; Webster, Bean, Gorman, Chambers, & Kawaoka, 1992)

Pandemic influenza: a widespread and deadly human influenza strain that could potentially result from mutations to an HPAI virus, rendering it easily transmissible to and between humans (Cox & Subbarao, 2000)

Risk assessment: a systematic process for gathering, assessing and documenting information to determine the likelihood and impact of events on public health in order to assign a level of risk and guide actions to manage and reduce negative consequences. The process involves assessment of three components: the hazard, possible exposure to the hazard, and the event context (WHO, 2016)

Risk perception: the ability of individuals to discern the probability and severity of an adverse event (Inouye, 2014)

Severe seasonal influenza: case of seasonal influenza requiring hospitalization

Surveillance: intensive data recording that encompasses gathering, documenting, and analyzing data to evaluate disease status for disease eradication or control (USDA-APHIS, 2015)

Chapter 2: Review of Related Literature

Introduction

To provide a broad understanding of avian and pandemic influenza, preparedness, and perceptions, a review of the recent literature was conducted. This review focused on highly pathogenic avian influenza (HPAI), its potential to develop into human pandemic influenza, and perceptions of preparedness for a pandemic. The first section describes the structure and behavior of HPAI viruses, its initial detection in poultry, and recent HPAI outbreaks in the US. The second section describes the initial cases of HPAI in humans and research into its pandemic potential. The third section reviews studies on preparedness of health professionals and others for an influenza pandemic. The fourth section describes surveillance work to detect the virus in poultry and wild waterfowl in order to prevent or contain outbreaks. The final section of this review explores the theoretical basis behind this study on awareness and risk perception.

Structure and Behavior of HPAI Viruses

Structure of HPAI viruses. All human influenza viruses are ultimately of animal origin, and aquatic birds are the natural hosts of all Type A influenza viruses (CDC, 2015a). Avian influenza (AI) viruses are Type A viruses belonging to the *Orthomyxoviridae* family and contain surface molecules known as hemagglutinins (HA) which enable them to infect cells and neuraminidases (NA) which enable them to leave the cells and be transmitted to other organisms (Webster et al., 1992). To date, 18 unique HA subtypes and 11 NA subtypes have been recognized (CDC, 2015a). Most HPAI viruses are of the subtype H5, although an H7

pathogen emerged in 2013 (Peng et al., 2014). The NA subtype is more variable and appears to change more frequently (CDC, 2016b).

Behavior of HPAI viruses. Virus particles are shed in the saliva, nasal secretions, and feces of infected birds and can infect other birds through direct contact (CDC, 2015a). North America experienced an outbreak of H5N2 in Texas in 2004 and a more widespread and severe outbreak of H5N1/2/8 in approximately 20 US states in December 2014 thru June 2015. A smaller outbreak of H7N8 in Indiana was detected in January 2016 (CDC, 2016b).

Until the emergence of HPAI H5N1 in 1997, it was believed that avian influenza viruses were evolutionarily stable and benign in wild birds, with only rare incursions into poultry, and there was “no evidence that humans are susceptible to natural infection with true avian influenza viruses” (Webster et al., 1992, p. 171). These viruses were, however, recognized as reservoirs of genes for pandemic virus emergence. The existence of HPAI has been a reminder of the potential for emergence of novel viruses similar to the deadly pandemic H1N1 influenza of 1918, which killed an estimated 50 million people worldwide (CDC, 2016a; Cox & Subbarao, 2000).

Human Infections

History of human infections. In May 1997, a three-year-old boy in Hong Kong died from Reyes syndrome, acute influenza pneumonia and respiratory distress syndrome attributed to H5N1 after nearby outbreaks of H5N1 on chicken farms (Claas et al., 1998; de Jong, Claas, Osterhaus, Webster, & Lim, 1997). Eleven other cases in Hong Kong followed that year, with a

total of five fatalities (Yuen et al., 1998). While the researchers reporting on these initial cases sounded a pandemic warning to the world, it seemed unfounded at the time because after the initial 12 infections, the virus seemed to disappear and did not emerge again until 2003.

In February 2003, H5N1 struck another family in Hong Kong, killing a seven-year-old girl and her 33-year-old father and sickening the eight-year-old son, who eventually recovered (Peiris et al., 2004). The affected family had recently been visiting the Chinese mainland, where they had been in close contact with chickens. Until this time, little was known about H5N1's mechanism of action in humans and why human infections were so rare.

Using cultured cells, Matrosovich and colleagues (Matrosovich, Matrosovich, Gray, Roberts, & Klenk, 2004) determined that, while human type A influenza infects nonciliated secretory cells in the airways, avian influenza infects ciliated airway cells. The receptors on these ciliated cells enable the avian virus to infect them, but only rarely. In contrast, nonciliated cells contain different receptors which easily enable infection by the human influenza virus. This explained why HPAI rarely causes human disease and why human-to-human transmission of HPAI is rare.

Risk factors. A meta-analysis of studies of risk factors for severe H5N1 outcomes (Mertz et al., 2014) revealed that females and patients over age five years experienced worse outcomes. The authors examined 20 studies comprising 539 human cases of H5N1 between 1998 and 2010 (data sets overlapped). Females in these studies had a significantly higher incidence of mortality than males; however, this may reflect the cultural tendency of females rather than males to closely tend poultry in the affected countries.

Human infections to date. The World Health Organization reported a total of 854 human cases of H5N1, of which 450 were fatal, through July 2016 (WHO, 2016). The greatest numbers of cases have been reported in (in descending order) Egypt, Indonesia, Vietnam, Cambodia, China, and Thailand. The only case reported in North America occurred in Canada in 2013 (WHO, 2016). Between February and May 2013, a novel H7N9 highly pathogenic AI virus emerged in China and killed 35 of 130 people infected (Peng et al., 2014). All of these cases were bird-to-human with no human-to-human transmission detected. However, this event raised the alert for pandemic viruses other than the H5 prime suspects. Qin et al. (2015) compared the epidemiology of H7N9 and H5N1 and reported that diagnosed cases of H7N9 are biased toward older, more severe cases, with relatively few new, mild cases detected. This was not true of H5N1 cases in the study. Thus, even though H5N1 causes more severe disease, H7N9 might have greater pandemic potential because there appear to be a significant proportion of mild, undiagnosed cases, allowing the opportunity for evolution of H7N9 into a pandemic strain.

In early 2017, researchers in China found a mutation in H7N9 infecting humans that had transformed it from a historically low-pathogenic virus to a highly pathogenic virus. As of 14 February 2017, WHO reported a total of 1223 laboratory-confirmed human H7N9 infections, including at least 380 deaths. 305 of these H7N9 cases were confirmed during the period 17 January to 14 February 2017. (WHO, 2017b). H7N9 thus moved to the forefront as a candidate for a pandemic virus.

Human exposures during 2015 bird outbreaks. During the widespread US HPAI outbreaks of 2015, Arriola et al. (2015) investigated human exposures by tracing outbreaks in birds and contacting state and local health departments to identify persons reporting acute respiratory infections after being exposed to sick birds. Public health officials collected respiratory specimens from these people and the authors tested the samples for the presence of H5 avian influenza viruses. Of the 164 human exposures in 60 bird outbreaks, none showed evidence of H5 infection. The authors concluded that the brevity of exposures and the overall better sanitary conditions in the US precluded human infection.

Lai et al. (2016) reviewed case data for human H5N1 infections through 2015. According to the authors, the virus primarily struck young people; 41% of the 881 cases were under age 15 and 80% were under age 35. However, younger people were more likely to recover, while older people had a higher fatality rate. The overall case fatality rate was 53%, but fatality risk dropped from a high of 71% before 2009 to 43% in recent years. Fatality rate varied by geographic region, with much higher rates in Asia than in north Africa. Eighty-six percent of cases reported exposure to sick or dead poultry before onset of illness, while six percent of cases reported exposure to a person ill with H5N1 prior to onset of illness (Lai et al., 2016).

Prevention. Miller, Viboud, Balinska, and Simonsen (2009) reviewed historical flu pandemics of all types and noted five characteristics of past pandemics:

- 1) a change in the virus subtype,
- 2) higher mortality rates in younger age groups,
- 3) successive waves of illness,

- 4) increased transmissibility compared to seasonal influenza, and
- 5) varying impact by geographic region.

The authors recommended that preparedness policy should take all of these characteristics into consideration, not only the first, when developing vaccine prioritization guidelines.

Much attention has been given elsewhere to seasonal influenza immunization programs, but the seasonal vaccine is unlikely to protect against a pandemic virus (CDC, 2016c). Pandemic flu will likely not have an effective vaccine for at least the first wave of illness. Using current technology, preparing and mass-producing a vaccine for a novel flu strain takes approximately six months (CDC, 2015b). Therefore, prevention will rely largely on social distancing and hygiene. However, the effectiveness of these measures is not reliable in all populations. Misegades (2009) conducted randomized controlled trials on the effectiveness of hand hygiene and respiratory etiquette among 2,300 students at the University of California-Berkeley and concluded that these non-pharmaceutical interventions did not significantly reduce flu-like illness in this population.

Pandemic Preparedness

Health sector preparedness. The WHO recognized the pandemic potential of H5N1 and in 2005 published its report *Avian influenza: Assessing the pandemic threat* (WHO, 2005). Subsequently there were a number of studies on pandemic influenza preparedness. Some of these addressed risk perception and preparedness of occupational groups such as nurses and physicians. Balicer et al. (2006) found that nearly half of their sample of 308 public health

workers were unlikely to report to work if a pandemic occurred. These authors attributed the results to knowledge gaps and peripheral concerns that affected the workers' risk perception. Barnett et al. (2009) surveyed 1,835 public health workers and concluded that the interaction of perceived risk and perceived efficacy influenced the workers' willingness to respond to an epidemic. Their study did not categorize respondents by role, so it is unknown how role affects their perceptions; but overall, 84% of sampled workers reported being at least somewhat willing to respond to a pandemic.

Schneider (2007) studied the perceptions of 20 rural hospital pandemic preparedness coordinators and observed that overall, they believe they do not have adequate information to successfully implement preparedness programs. Oberdorfer (2008) examined 86 physicians' perceptions of their pandemic preparedness; only 28% of physicians surveyed reported being prepared. The overall results of these studies indicated that health professionals do not feel prepared for an influenza pandemic and that more training and education is needed.

The preceding four studies were done in the US, which has not experienced a serious nationwide infectious disease crisis. In contrast, a 2007 study of perceptions of 999 nurses in Hong Kong reported that nurses who had worked directly with SARS (severe acute respiratory syndrome) patients through the 2003 epidemic were much more likely to express willingness to report to work in a flu pandemic (Tam, Lee, & Lee, 2007). These nurses were also more vigilant about infection control and more risk-aware than those who had not worked directly with SARS patients.

Government and business sector preparedness. Other studies of risk perception and preparedness focused on the government and business sectors. A study of 1,566 German municipal workers (von Gottberg, Krumm, Porzsolt, & Kilian, 2016) reported that up to 20% were unwilling to report to work in a flu pandemic. Watkins et al. (2007) interviewed 201 small and medium-sized business owners and managers in Australia about their perceptions and preparedness for pandemic influenza. Only six percent of businesses sampled had a preparedness plan and most were very unprepared for a flu pandemic. An exception to this trend was the egg industry, which developed an extensive preparedness plan to avoid interruptions in egg supply in a severe avian influenza outbreak (Voss et al., 2012). Carameli (2010), in a dissertation unrelated to pandemic flu, tested a model of workplace-household preparedness on over 2,500 employees of 16 companies and concluded that the interrelatedness of home and workplace and their combined effect on risk perception and efficacy should be recognized in business disaster preparedness plans.

General public preparedness: Knowledge and perception. Several studies addressed general public perceptions of preparedness. Maunula (2007) surveyed 161 Ontario residents and found that while respondents knew what a pandemic was, they underestimated its impact. This study sample desired more information and greater involvement in the preparedness planning process. In a 2006 telephone survey of over 1,600 Georgia residents (Paek, Hilyard, Freimuth, Barge, & Mindlin, 2008), approximately half of respondents had low understanding of what avian flu is and how it could become a pandemic. Respondents differed by demographic group in their perceived susceptibility and severity of flu risk. Overall, respondents indicated that they trust the government to protect them and support government actions in the event

of a pandemic. An exception was the acceptability of using “not fully approved” (i.e. investigational) drugs to treat or prevent influenza, which most respondents did not support.

Braunack-Mayer et al. (2010) conducted focus groups of nine to 12 people in Australia to gauge opinions about the allocation of scarce vaccines and antivirals and the acceptability of quarantine and social distancing in a pandemic, using scenarios to gauge opinions. Overall, respondents were in favor of allocating scarce medicines to preserve societal function. They were divided on the use of quarantine and social distancing for infection control unless necessary, and felt that those quarantined should receive financial and psychological support from the government.

Marshall et al. (2009) studied community knowledge about and attitudes toward pandemic flu and the acceptability of risk reduction strategies in South Australia. They found that 50% of 1,975 survey respondents had no knowledge of pandemic flu; knowledge was positively correlated with socioeconomic status, education, and age of 45-64 years. Older or younger age groups possessed less knowledge of pandemic flu. Concern about a pandemic was highest in groups with less knowledge; these groups were also characterized by a reliance on vaccine and antivirals and lack of trust in government. Another Australian study (Abeyasinghe & White, 2011) compared the communication perspectives of a national newspaper and the federal government regarding an avian influenza outbreak in terms of blame, risk, and responsibility. Both sources perceived AI as an exogenous “Asian threat;” they differed in their view of Australia's preparedness, with the government presenting a much more positive view.

At a 2008 meeting of the CDC, Vaughan and Tinker (2009) presented recommendations on improving flu risk communication to vulnerable populations. According to these authors, health disparities, differences in treatment access, living conditions, health literacy, language, immigration status, risk perceptions, and confidence in government response to a flu pandemic are all important considerations when designing communications. In addition, they noted that a pandemic is a dynamic rather than a linear event; therefore phased and participatory communication should give the best results.

General public preparedness: Psychological preparedness. Prati et al. (2011) applied a social cognitive model to 1,010 Italians' perceptions of pandemic threat and found that emotional responses to a specific risk influence behaviors. In other words, if family and friends were worried about a pandemic, respondents were worried too; furthermore, worry influenced actions related to pandemic preparedness. Recognizing the lack of psychological trauma support in most disaster preparedness plans, McCabe et al. (2013) developed and tested a guided preparedness planning (GPP) model to study the feasibility of partnerships between rural health departments, churches, and the Johns Hopkins health system. They designed training sessions and workshops for 178 community members interested in disaster preparedness support, recruiting participants through churches and community leaders. The authors found that the GPP model was feasible, effective, sustainable, and scalable and can build capacity in emergency planning efforts.

Pandemic Potential of Viruses

A number of recent studies of avian and pandemic influenza have focused on assessing the pandemic potential of avian flu viruses using genetically engineered viruses (Herfst et al., 2012; Imai et al., 2012; Mehle et al., 2012; Osterholm & Kelley, 2012; Watanabe et al., 2014). The Kawaoka (Watanabe et al., 2014) and Fouchier (Herfst et al., 2014) research labs independently engineered a virus that demonstrated effective mammalian transmission in ferrets (that is, no bird host was needed). These findings showed that human-to-human AI transmission could develop with a relatively small number of genetic changes, all of which are possible in nature. Taubenberger's lab (Mehle et al., 2012) observed that swine can serve as a "mixing vessel" for reassortment of cocirculating human, avian, swine, and 2009 H1N1-like viruses; this mixing of viruses has the potential to generate novel flu viruses with greater transmissibility and pathogenicity.

Poultry Farm Biosecurity

Current intensive poultry farming practices provide an ideal setting for the rapid transmission of HPAI; therefore, biosecurity is critical in preventing HPAI infection of flocks. USDA-APHIS (the federal agency responsible for animal health issues) lists biosecurity practices for poultry farmers including:

- 1) removing standing water,
- 2) excluding wild waterfowl from ponds or ditches near poultry barns,
- 3) avoiding the use of untreated surface water for watering poultry or cleaning barns or equipment,

- 4) avoiding feeding wild waterfowl or allowing them to access farm food sources,
- 5) covering carcasses and trash,
- 6) preventing wild birds from nesting in or near barns, and
- 7) using wildlife deterrents.

In the event of an HPAI outbreak on a farm, USDA-APHIS follows a 60-120 day protocol, which includes quarantine, depopulation, compensation, disposal, virus elimination, testing, and finally restocking the birds. Biosecurity is maintained after restocking to reduce future outbreaks (USDA-APHIS, 2015). The Minnesota Board of Animal Health (BAH) is the agency in charge of responding to and containing HPAI outbreaks on Minnesota farms using the USDA-APHIS protocol (Minnesota Board of Animal Health, 2016).

Surveillance and Epidemiology

With the knowledge that wild waterfowl are reservoirs for HPAI viruses, a number of recent studies have focused on surveillance for HPAI in wild birds (Bahl et al., 2016; Bevins et al., 2014; Flint, Pearce, Franson, and Derksen, 2015; Fries et al., 2015; Hill et al., 2011). These studies confirmed that several species of dabbling ducks are the primary carriers of HPAI and that interactions between birds during migration and wintering (where the ducks are greatly concentrated) facilitates the spread of virus. On-farm contact between wild ducks and domestic poultry are an efficient vehicle for transmission of HPAI (APHIS Veterinary Services, 2015; Flint et al., 2015), so surveillance and control measures should be applied where poultry are abundant, as in southern Minnesota. Bahl and colleagues (2016) reported frequent two-way transmission of HPAI between wild and domestic ecosystems. They observed high rates of viral

transmission from domestic to wild birds within a region and the potential for wild birds to transmit the virus to poultry between regions. However, they found the highest rates of viral flow between regions in domestic flocks, indicating that the poultry trade may play a major role in spreading viral populations. In the authors' words, "[I]nteractions between migratory birds and animal productions systems contribute to the emergence of AIV. The assumption of unidirectional viral flow from wild birds to domestic poultry provides an incomplete picture of influenza ecology and may confound control efforts" (Bahl et al., 2016, p. 2).

Epidemiological studies of HPAI have shown the likely pathways of transmission between and within poultry farms (APHIS Veterinary Services, 2015; Burns, Guerin, Kelton, Ribble, & Stephen, 2011) with a view to improving farm biosecurity. Burns and associates (2011) studied human contact pathways and demonstrated that social visitors (rather than farm employees) may be responsible for interfarm transmission of HPAI, indicating that biosecurity in Canadian farms needs improvement. The US has stringent biosafety protocols in place to maintain clean-to-dirty lines of contact on poultry farms, but the severe 2015 HPAI epidemic calls into question how strictly those protocols are being followed (APHIS Veterinary Services, 2015, 2016). Dargatz, Beam, Wainwright, and McCluskey (2016) conducted a case series of infected turkey farms after the 2015 outbreaks to generate hypotheses about disease introduction and spread and concluded that farm equipment and other fomites shared between farms were likely to spread the virus. Other possible vectors were wild waterfowl using farm ponds and small birds such as sparrows (Dargatz et al., 2016). Improving biosecurity by disinfecting vehicles and equipment and keeping wild birds away from poultry can reduce virus transmission.

More recently, a large outbreak of HPAI in Minnesota, Iowa, North and South Dakota, and Wisconsin in spring and summer 2015 (APHIS Veterinary Services, 2015, 2016) has not only had serious economic consequences for poultry farmers in the Midwest but has again heightened concerns about the likelihood of pandemic flu.

One might ask about the feasibility of vaccinating poultry to prevent infection and avoid having to cull entire flocks. The USDA-APHIS *2016 HPAI Preparedness and Response Plan* (USDA-APHIS Veterinary Services, 2016) reports that a closely matched vaccine for the 2015 outbreak was not available and provides a rationale for not relying on vaccines to prevent or control future outbreaks. Vaccines would need to be developed, mass-produced, and stockpiled in short order in order to be an effective control agent. As mentioned earlier in this paper, production of a vaccine takes several months, during which a virus is likely to mutate, rendering the vaccine ineffective. Additionally, vaccinating poultry may negatively affect poultry exports, according to USDA-APHIS (2016). If vaccination were used as a suppression strategy, it would likely be focused in a defined geographic area where disease was spreading rapidly.

Alternative Viewpoints on Pandemic Risk and Preparedness

It is worth noting that there are a few dissenting voices in the literature. Koblenz (2009) argued that despite prevailing views of a novel pandemic flu equalling or surpassing the morbidity and mortality of the 1918 pandemic, modern advances would greatly lessen the severity of a pandemic. He cited four differences between 1918 and current conditions to support his argument:

- 1) Advance warning of a pandemic due to understanding of viral genetic shift

- 2) A global human health surveillance and response system
- 3) New medical countermeasures such as vaccines and antivirals as well as a better understanding of disease transmission
- 4) No global conflict causing crowded and unsanitary conditions

Sanford, Polzerb, and McDonough (2016) used critical discourse analysis to argue that the global emerging infectious diseases paradigm uses power structure to frighten and control people. The pandemic preparedness perspective, they assert, gives global power structures like WHO control over policies by viewing a pandemic as a security threat. The authors deconstructed the language of WHO publications as evidence of its use of power through language.

Risk Assessment

The WHO has developed a tool for influenza pandemic risk assessment (TIPRA) to evaluate the risk of sustained human-to-human transmission of an HPAI virus (WHO, 2016). Using this tool, flu experts can score virus risk elements such as genetic characteristics, receptor-binding properties, efficiency of transmission in animal models, human infection and disease severity, human immunity, and virus ecology and epidemiology in animals. This information is used to identify knowledge gaps and guide research and surveillance activities. Because TIPRA is a WHO development, it is designed for national and global-level use rather than local or regional use. However, some of its principles might be applicable to local risk assessment projects.

Theoretical Basis

Two theoretical models inform this study; the first attempts to explain community health promotion and the second addresses individual behavior. The social ecological model (SEM) of health promotion (Stokols, Grzywacz, McMahan, & Phillips, 2003) combines the concepts of community capacity building and health-supportive environments to provide a broad basis to understand how human environments can best support health. Building community capacity involves:

- 1) mobilizing and channeling existing community human and material assets into productive investments to realize improved health outcomes,
- 2) enlarging and diversifying community assets, and
- 3) empowering community members to continue to devote time, energy and resources to sustain their prioritized health improvement efforts.

The process begins with identifying high-priority health problems and the most appropriate resources to address them, and it continues by developing “high-leverage” programs that are most likely to achieve significant health improvements while being cost-effective (Stokols et al., 2003).

A key concept of the SEM is *social validity*, which emphasizes the value of the health research or interventions to society. In order to have social validity, a study or intervention must address problems that are serious and prevalent in the population, avoid unintended negative side effects, be economically feasible, and reflect community priorities and commitments (Stokols et al., 2003).

In a PhD dissertation on the relationship between workplace and employee household preparedness, Carameli (2010) argued that social ecological models are the best approach for studying private sector preparedness, because home and workplace are interdependent. The SEM was the model chosen to view the issue of community awareness and perception of avian/pandemic influenza because it accounts for the multiple levels of influence (individual, social, community, and policy) that affect awareness and perception of health issues and because it employs a variety of human and material community resources to promote knowledge and healthy behaviors.

Individual attitudes and perceptions of HPAI/pandemic flu and appropriate interventions might best be understood using the Extended Parallel Process Model (EPPM) (Witte, 1992). This model posits that fear messages alone are ineffective because when people have low perceived efficacy in the face of a perceived threat, they respond out of fear and in fact do the opposite of what is recommended because they feel they cannot deter the threat (fear control process). When the threat is perceived as trivial, people take no action. However, when both perceived threat and perceived efficacy (feeling they can effectively control or avert the threat) are high, fear messages motivate people to take positive actions to protect their health (danger control process) (Witte, 1992).

Two of the studies included in this literature review employed the EPPM. Barnett et al. (2009) concluded that public health workers involved in their study that were both concerned about pandemic flu and confident in their ability to fulfill their role expressed greater willingness to respond in a pandemic. Von Gottberg et al. (2016) reported similar results, with

the addition that willingness to respond was positively correlated with respondents' perceptions of occupational role importance and sense of duty. The EPPM effectively informs message development in this study because while avian/pandemic influenza may not be a widely recognized threat, it is a serious one, and people have the ability to avert or manage the threat if they are aware of the risk factors and prevention behaviors.

In conclusion, this literature review has summarized the avian and pandemic influenza literature relating to the nature and behavior of the viruses and perceptions of risk and preparedness among various demographic and professional groups.

Chapter 3: Research Methodology

Introduction

To investigate knowledge and risk perception of avian/pandemic influenza in southern Minnesota, a survey of the adult population of southern Minnesota was conducted. This chapter details the research methodology and design, characterization of variables, sample selection, sampling procedures, and survey design for the avian/pandemic influenza awareness and risk perception study. Description of the study period and data analysis are also included here.

Description of and Rationale for Research Design

This study is a cross-sectional correlational study (Cottrell & McKenzie, 2005), comparing awareness of avian/pandemic influenza across various segments of the target population. A cross-sectional study design was chosen because time limitations required data to be collected over a period of approximately one month. A correlational design was used because variables of interest are likely to correlate with flu awareness, but causal relationships are unlikely to be apparent, precluding an experimental approach.

Independent variables for this research question are: 1) individual's occupational role, 2) educational level (high school, some college, bachelor's degree, or graduate-level); and 3) previous experience with severe seasonal influenza requiring hospitalization (self or immediate family). The dependent variable for this question is avian influenza knowledge and risk perception on a scale of low to high, based on answers to factual questions and Likert-scale questions. Extraneous variables that were not controlled are gender, race, cultural or

philosophical beliefs about food animals (e.g. veganism), current local outbreak of avian influenza, and relative severity of current seasonal influenza.

Subject Selection

This study's priority population is adults ages 18 years and over in southern Minnesota. A convenience sample of 99 adults from this population was obtained, using employees recruited with permission from a sample of 20 large employers in the region.

Instrumentation

An 18-question survey was designed to measure knowledge and risk perception of influenza in general, avian influenza, and its potential to develop into pandemic influenza. The survey was administered online using Qualtrics (Qualtrics, LLC, 2017). All survey questions were of the "check box" type. Most questions had only one correct answer; others had opinion or Likert scale (Likert, 1932) responses. Questions were designed to measure whether respondents understand 1) what avian influenza is, 2) its transmissibility to humans, 3) the symptoms of influenza (as distinguished from "stomach flu" or the common cold), 4) how influenza is spread, 5) what pandemic influenza is, 6) how it is different from seasonal influenza, and 7) vaccine efficacy against pandemic influenza. Several questions measured individual risk perception using a Likert scale; these questions were based on similar risk perception questions in a Federal Emergency Management Association survey (Federal Emergency Management Association [FEMA], 2009). Demographic information on employment role, education, and personal experience with severe influenza was collected at the end of the survey and was used

to assign respondents to independent variable groups. The survey is included in this thesis as Appendix A.

Face validity of the survey instrument was established by review by the author's thesis committee. Factual questions were used to measure knowledge and Likert-scale questions were used to measure flu risk perception. Major areas of flu knowledge were addressed in the survey. The author attempted to create value-neutral questions and design the questions to elicit the respondents' actual knowledge. Reliability was maximized by sampling various types of employers and institutions.

Procedures

The procedure consisted of a survey administered electronically to measure knowledge and risk perception of avian and pandemic flu. Survey questions were designed to answer the research questions being investigated. Knowledge questions in the survey were based on publicly available information about avian and pandemic influenza. Respondents were supplied with an electronic consent form and asked to complete an electronic survey described above. The survey was designed to be completed in approximately five minutes.

Data Collection

After the study proposal received approval from Minnesota State University- Mankato's Institutional Review Board, questionnaires were distributed electronically using Qualtrics (Qualtrics, LLC, 2017) through participating employers to individuals in late February and March 2017. Responses were collected thru March 31, 2017. Responses were collected and coded by the researcher using SPSS 23 (IBM, n. d.).

Data Processing and Analysis

Data from completed Qualtrics surveys were coded and entered into the SPSS 23 program (IBM, n. d.). Descriptive statistics were calculated to summarize overall level of avian and pandemic influenza knowledge and overall risk perception. Scores on the knowledge section of the questionnaire were compared across employment types and educational levels. The data were further categorized by the respondent's answer to the question about whether they or a close family member had had a case of influenza requiring hospitalization. Scores were based on the number of correct answers to knowledge questions and were used as an indicator of avian and pandemic flu knowledge. Answers to Likert-scale (Likert, 1932) questions were used as an indicator of perception of preparedness. The remaining survey questions were demographic items that determined placement in groups according to employment type, educational level, and personal experience with severe influenza.

Table 1 lists the research questions and analysis methods used to measure each one. Descriptive statistics were used to describe the overall level of knowledge about avian and pandemic influenza (Q1-Q12) and the overall level of risk perception (Q13-Q15). Analysis of variance (ANOVA; Fisher, 1970) was used to detect differences in knowledge by employment sector, educational level, and experience with severe seasonal influenza. The Spearman rank correlation test (Spearman, 1904) was used to detect any relationship between educational level and risk perception. The Mann-Whitney U test (Lund Research Ltd., 2013) was used to detect any relationship between experience with severe seasonal influenza and risk perception.

Table 1.

Research Questions and Analysis Methods.

Research Question (RQ)	Survey items used to assess RQ'S	Level of Data	Analysis needed to assess RQ
1. What is the overall level of knowledge about avian and pandemic influenza in the study population?	Q1-Q12	Nominal	Descriptive Statistics
2. What is the overall level of risk perception regarding avian and pandemic influenza in the study population?	Q13-Q15	Nominal	Descriptive Statistics
3. To what extent is knowledge about avian and pandemic influenza different among individuals in various employment roles?	Q1-Q12 and Q16	Nominal	ANOVA
4. To what extent is risk perception of pandemic influenza different among individuals in various employment roles?	Q13-Q15 and Q16	Nominal	ANOVA
5. What is the relationship between educational level and individuals' influenza knowledge?	Q1-Q12 and Q17	Nominal (1-12) and ordinal (17)	ANOVA
6. What is the relationship between educational level and individuals' pandemic influenza risk perception?	Q13-Q15 and Q17	Ordinal	Spearman Rank Correlation
7. To what extent does experience with severe seasonal influenza correlate with an individual's influenza knowledge?	Q1-Q12 and Q18	Nominal	ANOVA
8. To what extent does experience with severe seasonal influenza correlate with an individual's influenza risk perception?	Questions 13-15 and 18	Ordinal (13-15) and Nominal (Q18)	Mann-Whitney U test

Chapter 4: Results

Introduction

This chapter details the results of the survey described in Chapter 3. Sampling and demographic information is listed first, followed by results organized according to the four hypotheses and eight research questions listed in Chapter 1.

Sampling and Employer Participation

Twenty large employers in southern Minnesota were approached for employee participation in the survey. Most of these did not respond or denied permission to survey their employees. Four employers permitted some level of participation. Two of these, a state university and a community college, published the research request and survey link in their employee newsletter. One employer sent the research request to only their public health department employees. The remaining employer sent the request to all their employees. The survey was open for 33 days and was completed by a total of 99 people.

Demographic Information

Of the 99 survey respondents, 30 (30.3%) listed their employment role as education, 27 (27.3%) indicated a health profession, 39 (39.4%) chose the “other” category, only one (1.01%) listed agriculture as a profession, and two people did not answer the question. Educational level of the study sample encompassed a range including high school graduate ($n = 1$) to doctoral/professional degree ($n = 4$). However, most respondents had a 2-year or technical degree ($n = 19$, 19.2%), bachelor’s degree ($n = 37$, 37.4%), or master’s degree ($n = 24$, 24.2%).

Three people did not respond to this question. Ninety (90.9%) respondents indicated no personal or family experience with severe seasonal influenza, while 6 (6.1%) indicated such experience with a family member. No respondents indicated that they had personally suffered a severe case of seasonal flu, and three people did not answer.

Research Question (RQ) 1: What is the Overall Level of Knowledge about Avian and Pandemic Influenza in the Study Population?

This research question was answered using the 12 knowledge questions on the survey. Because one knowledge question was a “mark all that apply” question with two correct answers, the maximum possible knowledge score was 13. Mean knowledge score for the overall sample ($n = 99$) was 10.03 (SD = 1.42) on a 13-point scale, or 77.16% correct. Frequency data for knowledge questions is listed in Table 2.

While nine of the 12 knowledge questions (KQs) had correct response rates of 74% or greater, the remaining three questions had only a 40% correct response rate. These questions involved length of time needed to produce a pandemic flu vaccine (KQ9), the relationship between avian flu and pandemic flu (KQ11), and pandemic flu prevention behaviors (KQ12). Half ($n = 50$; 50.5%) of the respondents indicated that they thought the time needed to produce an effective pandemic vaccine was 12-18 months, whereas 40% gave the correct answer of 4-6 months. Nearly half ($n = 46$, 47.4%) of respondents indicated that there was no relationship between avian influenza and pandemic influenza, whereas only 40 (41.2%) correctly responded that pandemic influenza happens when an animal influenza virus changes so that it infects people, spreads easily, and causes many deaths because no one is immune to it. Finally, the

majority ($n = 56$, 56.5%) of respondents incorrectly indicated that an annual flu shot was either the most effective prevention against pandemic flu ($n = 22$) or one among several factors including good hygiene, avoiding sick people, and taking antibiotics ($n = 34$, 34.3%).

Interestingly, no respondents chose taking antibiotics as the single most effective prevention behavior.

Research Question 2: What is the Overall Level of Risk Perception Regarding Avian and Pandemic Influenza in the Study Population?

RQ2 was answered using the three risk perception questions. Responses to these questions were on a 5-point Likert scale, with a maximum score of 15. Mean risk perception score was 8.86 ($n = 97$; $SD = 1.94$). Most respondents perceived the likelihood of an influenza pandemic occurring in their community as moderately likely (3 on Likert scale, $n = 36$, 36.4%) or very likely (4 on Likert scale, $n = 24$, 24.7%), while approximately a third of respondents felt a pandemic was unlikely (2 on Likert scale, $n = 26$, 26.8%) or extremely unlikely (1 on Likert scale, $n = 7$, 7.2%). Similarly, most respondents believed that if a pandemic did occur in their community, its personal impact would be somewhat severe (3 on Likert scale, $n = 31$; 32.0%) or moderately severe (4 on Likert scale, $n = 28$, 28.9%). Approximately a quarter of respondents believed the impact of a pandemic would be mild (2 on Likert scale, $n = 22$, 22.7%) or slight (1 on Likert scale, $n = 3$, 3.1%). A large majority of the study sample ($n = 79$, 81.4%) indicated that they felt concerned ($n = 44$, 45.4%) or slightly afraid ($n = 35$, 36.1%) that a pandemic may happen, but confident that they are prepared to deal with it. Results of the perception of preparedness question are listed in Table 3.

Table 2.

Frequency of correct responses to knowledge questions.

Knowledge Question	Number answering correctly (n = 99)
1. Avian influenza (“bird flu”) is most commonly fatal to (kills) which of the following?	93
2. When was the most recent outbreak of avian influenza in Minnesota?	83
3. Can people get avian influenza from eating poultry that is properly cooked?	89
4. When people get influenza, what are the usual symptoms?	75
5. How can people get influenza? (Check all that apply) -Inhaling tiny droplets in the air coughed or sneezed by a person with influenza -Touching objects recently touched by a person with influenza	93 74
6. Is an antibiotic (for example, amoxicillin) an effective treatment for influenza?	88
7. The annual flu vaccine (“flu shot”) that is produced each year usually provides protection against:	94
8. The ability of a flu vaccine to prevent the flu (its effectiveness) depends on:	93
9. How long do you think it takes for scientists to develop and mass-produce a vaccine for a newly identified influenza strain?	40
10. What is an influenza pandemic?	91
11. What do you think is the relationship between avian influenza and pandemic influenza?	40
12. In the case of an influenza pandemic, what is the most effective way to avoid being infected by it?	40

Table 3.

Results of perception of preparedness question for all respondents (n = 97).

Which of the following best describes how I feel about the possibility of an influenza pandemic?	n	%
1. Confident that it will never happen, so I don't need to worry about it	2	2.06
2. Concerned that it may happen, but confident that I am prepared to deal with it	44	45.4
3. A little afraid that it may happen, but confident that I am prepared to deal with it	35	36.1
4. A little afraid that it may happen, and not prepared to deal with it	16	16.5
5. Very afraid that it may happen, and not prepared to deal with it	0	0

Research Questions 3 and 4: To What Extent are Knowledge (RQ3) and Risk Perception (RQ4) of HPAI as a Potential Source of Pandemic Influenza Different among Individuals in Various Employment Roles?

Employment categories analyzed were education, health professions, and “other”. Because only one respondent indicated employment in agriculture, that category was omitted from analysis. One-way ANOVA showed no difference in flu knowledge between employment sectors [$F(3, 93) = 1.16, p = .33$]. However, risk perception did differ by employment sector [$F(3, 93) = 4.16, p = .008$]. Further analysis revealed differences in mean perception scores. Health professionals had the highest mean score of 9.63 (SD = 1.50), followed by educators with a mean perception score of 9.10 (SD = 1.63); and those in the “other” category with a mean score of 8.21 (SD = 2.19). Educators ($\bar{x} = 3.23, SD = .77$) and health professionals ($\bar{x} = 3.26, SD = .94$) had similar mean pandemic likelihood scores, and both were higher than mean likelihood scores of respondents in the “other” category ($\bar{x} = 2.46, SD = 1.00$). Health professionals had

the highest mean pandemic severity scores ($\bar{x} = 3.85$, $SD = 1.03$), followed by similar mean scores for educators ($\bar{x} = 3.13$, $SD = .86$) and others ($\bar{x} = 3.00$, $SD = 1.08$). These results are summarized in Figures 1 and 2. No significant difference was found in perception of preparedness by employment sector [$F(3,93) = .774$, $p = .511$].

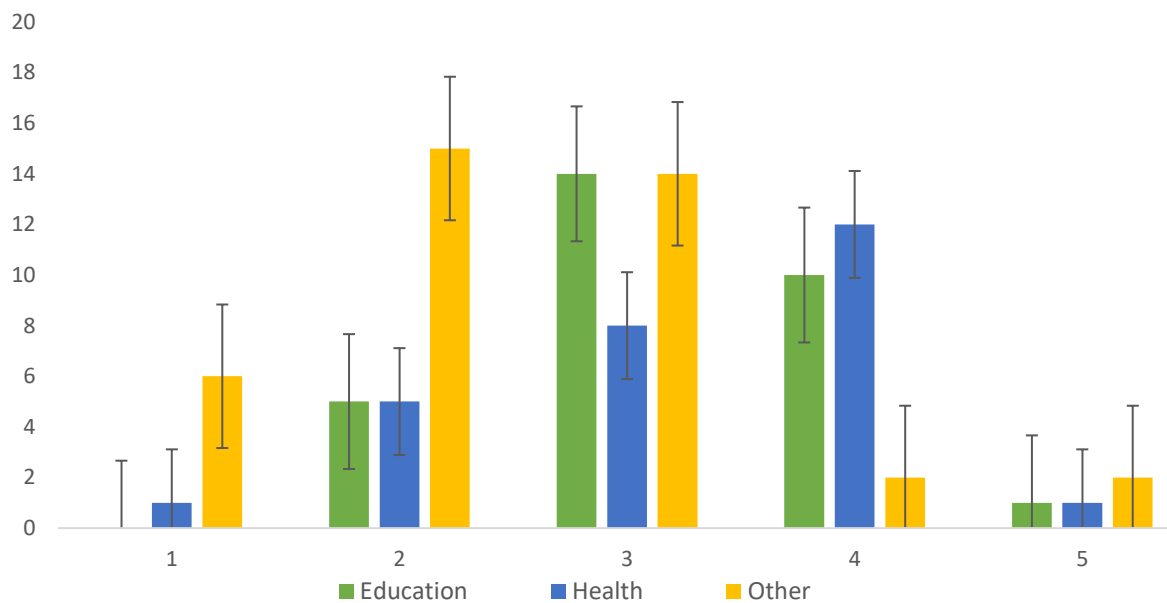


Figure 1. Perceptions of likelihood of an influenza pandemic occurring in respondent's community by employment sector (1 = extremely unlikely and 5 = extremely likely).

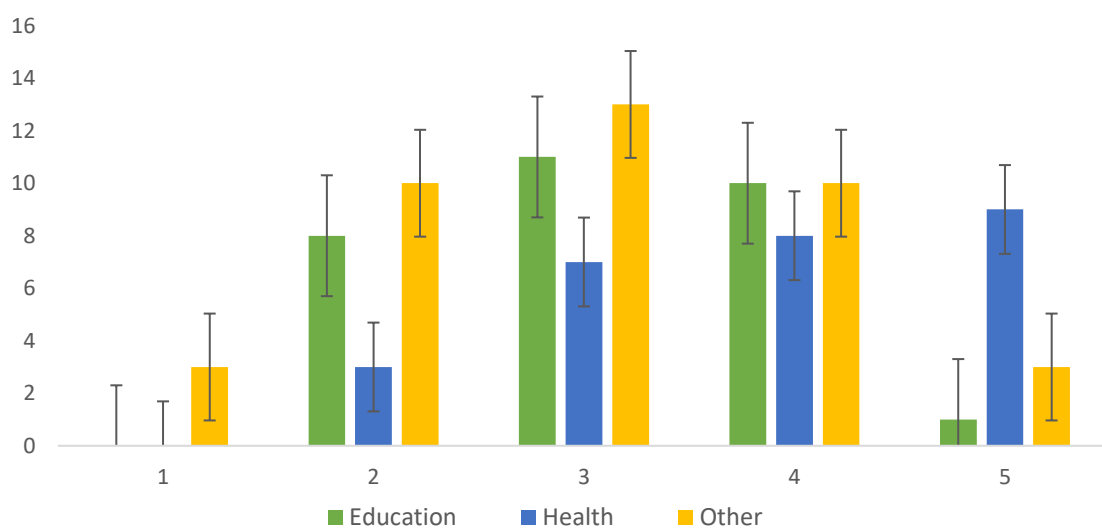


Figure 2. Perceptions of severity of personal impact of an influenza pandemic occurring in respondent's community by employment sector (1 = not at all severe and 5 = very severe).

Research Questions 5 and 6: What is the Relationship Between Educational Level and Individuals' HPAI Knowledge (RQ5) and Risk Perception (RQ6)?

One-way ANOVA revealed no significant difference in flu knowledge [$F(6, 89) = 1.65, p = .14$] by educational level. A Spearman rank correlation showed no significant correlation between risk perception and educational level [$r(94) = .129, p = .21$].

Research Questions 7 and 8: To What Extent Does Experience with Severe Seasonal Influenza Correlate With an Individual's HPAI Knowledge (RQ7) and Risk Perception (RQ8)?

One-way ANOVA showed no difference in flu knowledge between those with and without experience with severe flu [$F(1, 94) = .012, p = .913$]. A Mann-Whitney U test showed no difference in risk perception between those with and without experience with severe flu ($p = .72$).

Summary

The study sample showed a mean overall knowledge score of 10.03 on a 13-point scale (77.16%) and a mean risk perception score of 8.86 on a 15-point scale. No significant differences were found in knowledge scores by employment sector, education level, or experience with severe seasonal influenza. No significant differences were found in risk perception by education level or experience with severe influenza. Perception did differ by employment sector ($F(3, 93) = 4.16, p = .008$) and these differences were further explored in the graphs included in this chapter.

Chapter 5: Summary, Conclusions, and Recommendations

Introduction

The concluding chapter of this thesis summarizes the study and rationale, interprets the results of the avian and pandemic influenza knowledge and risk perception study, and draws conclusions about those results. Recommendations for future research and public health practice are also given.

Summary of Study

Recent large outbreaks of HPAI in the US as well as in several Asian countries, the demonstrated ability of avian influenza viruses to cause illness and death in humans, and the unpredictability of viral mutations that could enable efficient transmission of HPAI to and between humans underscore the importance of community preparedness for an influenza pandemic. Fundamental to preparedness is equipping the public with an understanding of the nature of avian influenza and its relationship to pandemic influenza as well as its similarities and differences compared to seasonal influenza. Understanding how people perceive their risk in the event of a pandemic is also important to developing appropriate interventions.

While few studies of influenza knowledge and risk perception or preparedness have been conducted in the US, existing studies indicate that knowledge is low among the public (Marshall et al., 2009; Maunula, 2007; Paek et al., 2008). Perception of pandemic preparedness is also likely to be low among the public (Prati et al., 2011) as well as health professionals (Oberdorfer, 2008; Schneider, 2007).

This study was conducted to investigate the level of knowledge and risk perception about avian and pandemic influenza among adults living in southern Minnesota. An 18-item electronic survey was designed to measure basic influenza knowledge and perception of risk in the event of a flu pandemic. Subjects were categorized by employment sector, education level, and experience with severe seasonal influenza. Participants were recruited through employers. A very limited number of employers agreed to participate in the study, leading to a small sample size.

Interpretation of Results

Overall knowledge. Analysis of overall knowledge scores indicated that influenza knowledge in the study sample may be inadequate for pandemic preparedness in the subject areas where correct response rates were very low. The knowledge gap regarding time needed to produce an effective pandemic vaccine may not be of large public health importance, but it is worth noting. Of greater significance is the knowledge gap regarding prevention behaviors and the relationship between avian influenza and pandemic influenza. Numerous respondents believed that an annual flu shot was an effective way to prevent infection in a flu pandemic, but a match between the annual shot and a pandemic virus is unlikely (CDC, 2016c). More education about the importance of hygiene and social distancing as prevention measures is evidently needed. Many respondents did not understand the relationship between HPAI and pandemic flu, revealing an additional area where education is needed.

Overall risk perception. Overall mean risk perception score in this study was 8.86 on a 15-point scale, with lower scores indicating that the respondent did not perceive an influenza

pandemic as a serious risk either in likelihood or severity. Higher scores indicated an awareness of the likelihood and severity of a pandemic. Most respondents appeared to have a “concerned but confident” perception of their ability to respond to a pandemic. While the EPPM (Witte, 1992) predicts that people who have that perspective will respond most effectively to a threat, the knowledge gaps identified in this study indicate that perceptions of preparedness may not accurately reflect true preparedness for a flu pandemic.

Knowledge by employment category, educational level, and experience with severe seasonal flu. Knowledge scores in this study did not differ significantly by employment category, educational level, or experience with severe seasonal flu. Therefore, both the knowledge strengths and educational needs of the study population are likely similar.

Risk perception by employment category. Risk perception scores differed significantly by employment category in this study. Further exploration showed that the differences occurred in perceptions of likelihood and severity of a pandemic, but not in perception of preparedness. Health professionals had the highest overall risk perception scores, followed by educators and then those in the “other” category. Educators and health professionals had similar pandemic likelihood scores, and both were higher than likelihood scores of respondents in the “other” category. Health professionals had the highest pandemic severity scores, followed by similar scores for educators and others. These results may reflect the reality that health professionals work with ill people and may be focused on the influenza issue more than those in other employment sectors. It may also indicate that those in non-health professions may have insufficient influenza knowledge to inform their risk perception.

Conclusions

According to the results of this study, the first hypothesis, that knowledge and risk perception of avian/pandemic flu are low in the general population of southern Minnesota is supported. The hypotheses that individuals' knowledge and risk perception of avian/pandemic flu differs by educational level or by experience with severe seasonal influenza are not supported. The hypothesis that individuals' knowledge and risk perception of avian/pandemic flu differs by employment sector is partially supported. These results indicate that flu knowledge in the study sample does not differ by employment, but risk perception apparently does.

Because overall avian and pandemic flu knowledge is fairly low and does not differ among groups in the study population, it is evident that pandemic flu education in southern Minnesota could be improved. As the public becomes better informed about pandemic flu, risk perception may change to more accurately reflect the state of community pandemic preparedness.

Employer participation influenced the study sample and caused it to be biased toward health professionals and educators. Due to the small sample size and its nonrepresentative nature, this study should not be generalized to the overall population of the US or Minnesota.

Recommendations for Research and Practice

Research recommendations. While this study provides important groundwork for understanding the influenza health education needs of southern Minnesotans, more research is

needed to clarify the extent of those needs. Future studies should include a larger and more representative study sample. Efforts should be made to include all socioeconomic and ethnic groups. In addition, participants should be recruited in ways other than through employers, because employers were very reluctant to participate in a study for which they did not perceive a direct benefit to their interests.

Recommendations for public health practice. Results of this study indicate an apparent gap in pandemic flu knowledge across various groups which can be addressed by a community pandemic flu education campaign. Such a campaign could be developed at the county or community health board level and shared across the region. Emphases of the campaign should include 1) explaining the relationship between avian and pandemic flu and 2) identifying and demonstrating effective pandemic flu prevention behaviors.

A long-term goal for public health practice is to develop a pandemic flu preparedness program based on the social-ecological model (SEM) (Stokols et al., 2003) emphasizing community capacity building and social validity. In order to be effective, such a program would have to be community-driven. A pandemic flu education campaign could raise awareness of the problem and stimulate community engagement and buy-in for a preparedness program. In such a campaign, EPPM (Witte, 1992) principles should be applied in educational materials and training to encourage both concern about the risk of pandemic flu and confidence in preparedness.

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Appendix A. Survey Instrument

Knowledge and Perception of Avian and Pandemic Influenza Survey

Thank you for taking a few minutes to fill out this survey. Your honest responses will contribute important information about the understanding of an infectious disease and its risk factors. All information you provide will be kept confidential. No personally identifying information about you will be requested. Please answer according to your present knowledge, without consulting other resources. You may choose to not answer any question, and your participation is greatly appreciated.

For the purposes of this survey, the words “influenza” and “flu” have the same meaning.

A. Influenza knowledge questions

1. Avian influenza (“bird flu”) is most commonly fatal to (kills) which of the following?

- ☐ Chickens and turkeys
- ☐ Ducks and geese
- ☐ Songbirds such as robins and sparrows
- ☐ Humans

2. When was the most recent outbreak of avian influenza in Minnesota?

- ☐ 1918
- ☐ 1977
- ☐ 2005
- ☐ 2015

3. Can people get avian influenza from eating poultry that is properly cooked?

- ☐ Yes
- ☐ No

4. When people get influenza, what are the usual symptoms?

- ☐ Vomiting or diarrhea
- ☐ Cough, fever, sore throat, and fatigue
- ☐ Runny or stuffy nose and cough

5. How can people get influenza? (Check all that apply)

- ☐ Inhaling tiny droplets in the air coughed or sneezed by a person with influenza
- ☐ Touching objects recently touched by a person with influenza
- ☐ Getting an annual flu shot
- ☐ Eating poultry

6. Is an antibiotic (for example, amoxicillin) an effective treatment for influenza?

- ☐ Yes
- ☐ No

7. The annual flu vaccine (“flu shot”) that is produced each year usually provides protection against

- ☐ All known influenza viruses
- ☐ 3 or 4 influenza virus strains believed to be circulating in the population that year
- ☐ Any influenza virus that may develop in the future

8. The ability of a flu vaccine to prevent the flu (its effectiveness) depends on:

- ☐ The “match” between the vaccine and the virus that is circulating in the population
- ☐ The age of the person being vaccinated
- ☐ The vaccination site (such as the arm or leg)
- ☐ None of the above affect vaccine effectiveness

9. How long do you think it takes for scientists to develop and mass-produce a vaccine for a newly identified influenza strain?

- ☐ 2 weeks
- ☐ 2 months
- ☐ 4-6 months
- ☐ 12-18 months

10. What is an influenza **pandemic**?

- ☐ The increase of influenza cases that occurs locally every winter
- ☐ A worldwide outbreak of avian influenza that kills a lot of birds
- ☐ A worldwide influenza outbreak that affects up to millions of people and results in many deaths

11. What do you think is the relationship between avian influenza and pandemic influenza?

- ☐ There is no relationship between avian influenza and pandemic influenza. They are completely different diseases.
- ☐ Pandemic influenza means a worldwide outbreak of avian influenza that kills a lot of birds.
- ☐ Pandemic influenza happens when an animal influenza virus changes so that it infects people, spreads easily, and causes many deaths because no one is immune to it.

12. In the case of an influenza pandemic, what is the most effective way to avoid being infected by it?

- ☐ Get an annual flu shot
- ☐ Practice good hygiene (such as handwashing) and stay away from sick people
- ☐ Take antibiotics
- ☐ All of the above
- ☐ None of the above

B. Influenza perception questions

13. On a scale of 1 to 5, (1 = extremely unlikely and 5 = extremely likely), how likely do you think it is that an influenza pandemic will ever occur in your community?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

14. If an influenza pandemic did occur in your community, how severe do you think the impact would be on you personally on a scale of 1 to 5 (1 = not at all severe and 5 = very severe)?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

15. Which of the following best describes how you feel about the possibility of an influenza pandemic?

- ☐ Confident that it will never happen, so I don't need to worry about it
- ☐ Concerned that it may happen, but confident that I am prepared to deal with it
- ☐ A little afraid that it may happen, but confident that I am prepared to deal with it
- ☐ A little afraid that it may happen, and not prepared to deal with it
- ☐ Very afraid that it may happen, and not prepared to deal with it

C. Please share some information about yourself:

16. Please check the box that most closely describes your occupational (job) category.

- ☐ Agriculture or food production
- ☐ Education
- ☐ Health professions (such as nursing, medicine, or allied health)
- ☐ Other (none of the above)

17. Please check the box that most closely describes your highest level of education.

- ☐ Some high school
- ☐ High school graduate
- ☐ Less than two years of college
- ☐ Technical or 2-year degree
- ☐ Bachelor's degree
- ☐ Some graduate-level education
- ☐ Master's degree
- ☐ Professional degree or doctorate

18. Have you or someone in your immediate family ever had a case of influenza requiring hospitalization?

- ☐ Yes, myself
- ☐ Yes, close family member
- ☐ No

If you have any questions about this survey or the research study for which it will be used, please contact the researcher, Holly Munch, at holly.munch@mnsu.edu. Thank you again for your participation.